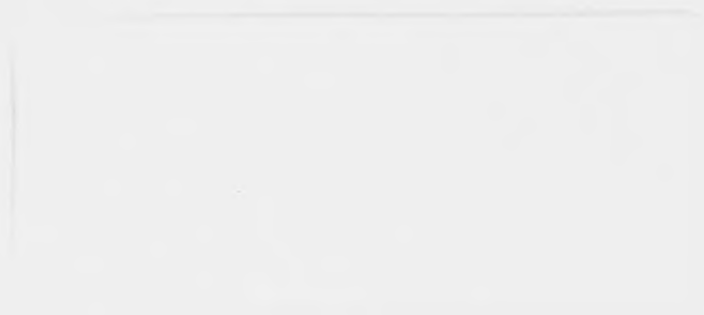


LYNX MANAGEMENT AND RESEARCH
IN THE NWT, 1988-89



Northwest
Territories

Resources, Wildlife &
Economic Development



LYNX MANAGEMENT AND RESEARCH
IN THE NWT, 1988-89

KIM G. POOLE
DEPARTMENT OF RENEWABLE RESOURCES
GOVERNMENT OF THE NWT
YELLOWKNIFE, NWT
1989



PROPERTY OF
G.N.W.T. DEPARTMENT OF
RENEWABLE RESOURCES LIBRARY

Manuscript Report 23
23
Renewable Resources Library
Government of the NWT
P.O. Box 1320
Yellowknife, NT
X1A 2L9

The interpretations presented in this report are those of the author and do not necessarily represent those of the Department.



ABSTRACT

This report summarizes lynx harvest trends, and management and research programs conducted during 1988-89 in the NWT. A total of 2037 pelts were harvested in the 1987-88 season, up 25% over the previous year, and average pelt price was \$390. Indications for the 1988-89 season are that the harvest increased substantially.

A total of 181 lynx carcasses were collected from trappers from Fts. Simpson, Providence and Smith to: 1) determine the most reliable pelt length (measured from the tip of the nose to the base of the tail) to separate kittens from older animals, 2) examine age and sex ratios in the harvest, and 3) examine body condition and reproductive rates. A pelt length of 89 cm (35 inches) appears to be the best dividing point to use for estimating the proportion of kits in the harvest. Kittens and yearlings accounted for 29% and 56%, respectively, of the sample. The proportion of kittens increased and yearlings decreased as the season progressed. Most (59%) of the animals harvested were males, with relatively more males taken in November and December (71%) than after 1 January (51%). Body condition (as determined by fat indices) was similar among the three communities. Reproductive rates, however, were significantly lower in Ft. Smith (mean 2.23 placental scars) than Fts. Providence (4.14) and Simpson (3.95).

Lynx pelts from across the NWT were measured to provide an indication of the proportion of kits in the harvest. Almost 26% of 1721 pelts were less than 89 cm in length and, therefore, were presumed to be kits. The proportion of kits in the harvest increased from 14% before Christmas, to 25% during January and to 40% in pelts measured later in the season.

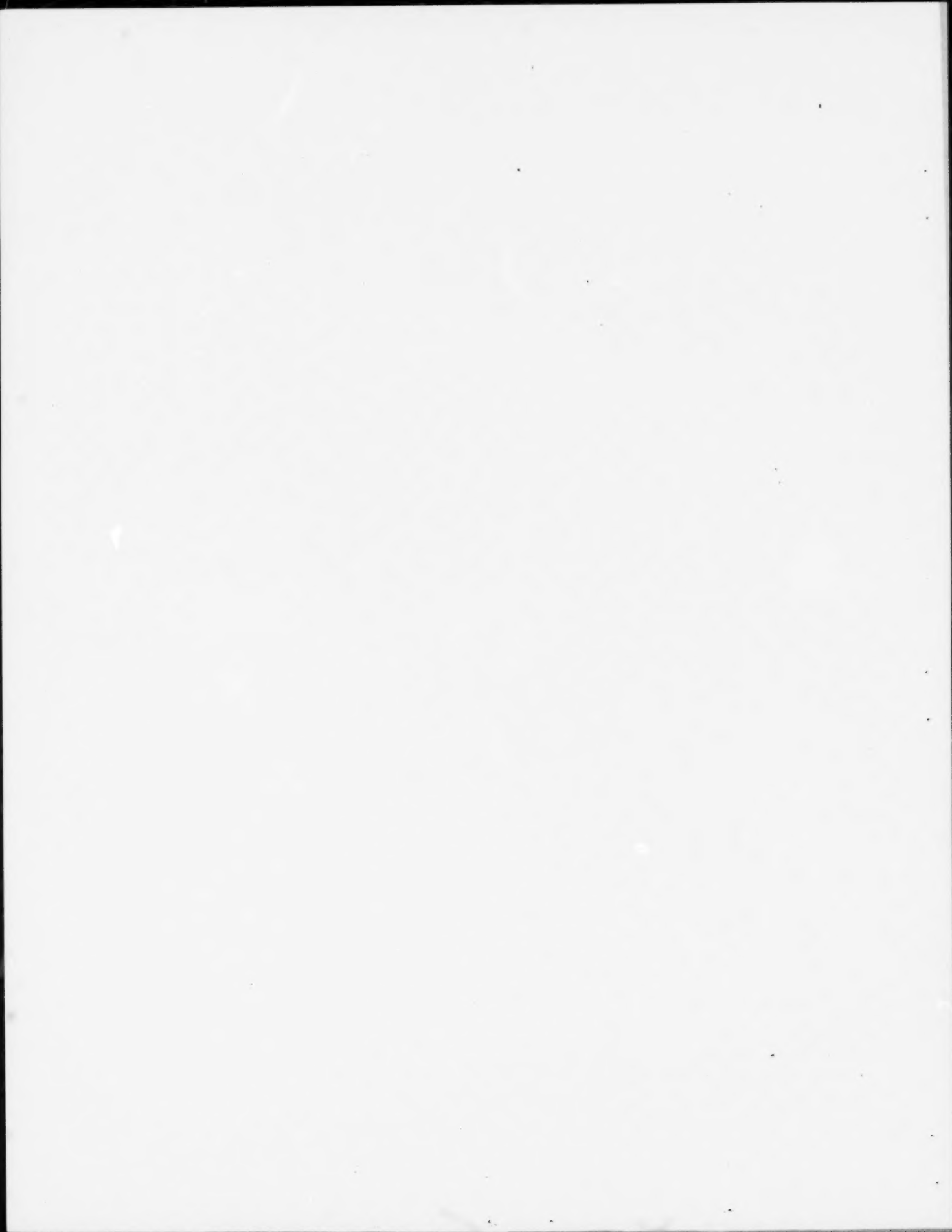
Lynx populations cycle in relation to numbers of their main prey, the snowshoe hare. An indication of hare densities from several areas in the NWT was provided by winter track counts and counts of hare pellets on permanent transects. In the past year, hare densities in the Great Slave Lake area generally levelled off or decreased slightly, while hare numbers along the western Mackenzie, especially in northern sections, increased. The highest densities recorded were in the Mackenzie Bison Sanctuary, reaching 5 hares per hectare (1300 per square mile).

A lynx live-trapping and radio-collaring program was initiated in the Mackenzie Bison Sanctuary in March 1989. The study was designed primarily to examine the importance of refugia, untrapped reservoirs of habitat, by examining home range size, distribution, habitat use and dispersal patterns. A 125 km² area was trapped in March 1989 using Freemont leg snares and Soft-catch padded traps, and 15 lynx were captured, 11 males and 4 females. Radio-collars were placed on 10 of these lynx. Radio-locating was conducted from the ground in March and early April, and began from the air on a bi-weekly basis in mid-April. Eight of the lynx have remained in the general area, while one female kit moved 105 km to the west and another female is

currently not "on air". No mortalities have been verified. Hare and lynx numbers in the Sanctuary were high during trapping. This study will be ongoing.

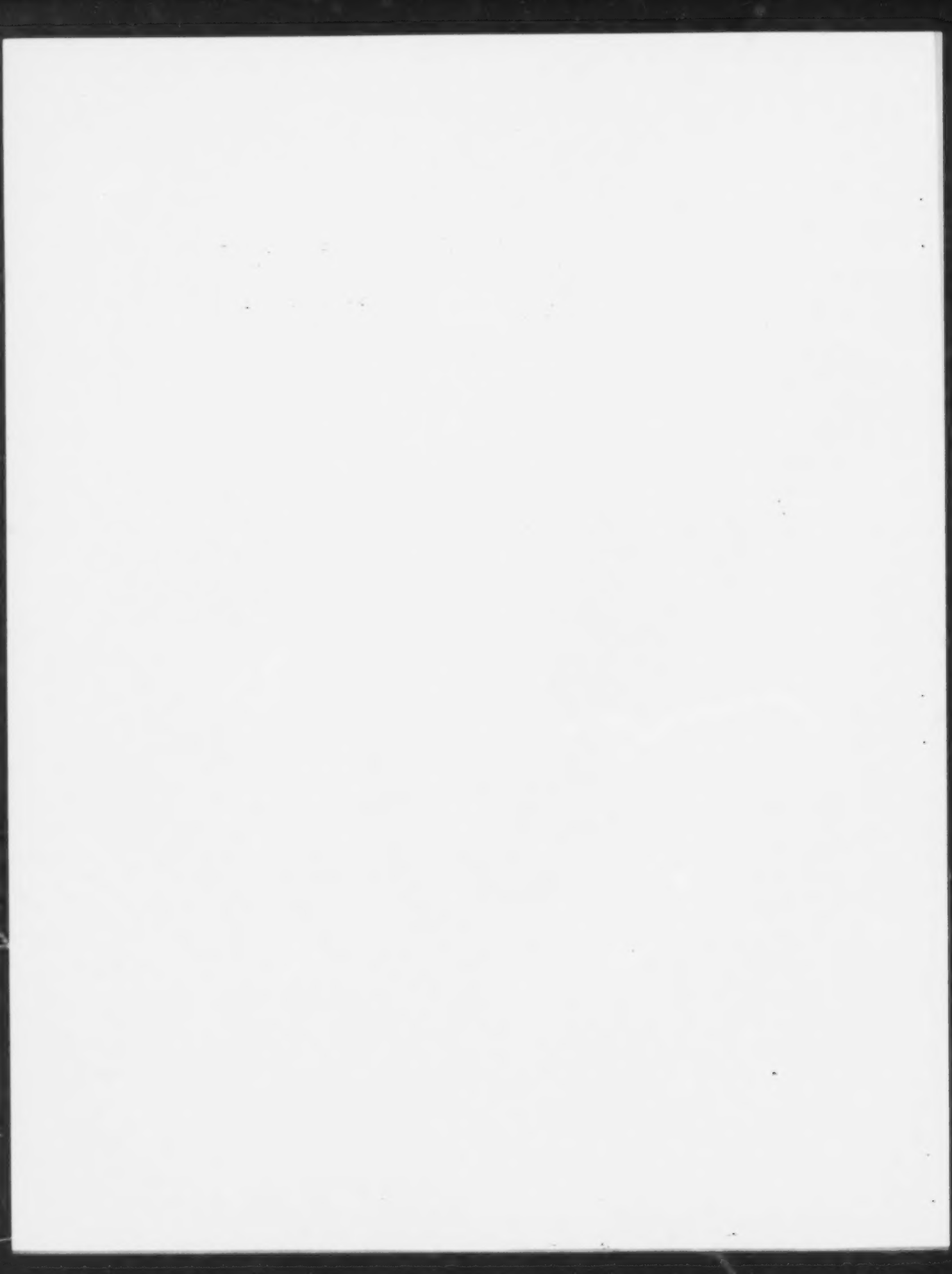
TABLE OF CONTENTS

ABSTRACT	iii
LIST OF FIGURES	vii
LIST OF TABLES	ix
INTRODUCTION	1
LYNX HARVEST	3
CARCASS COLLECTIONS	7
Introduction	7
Methods	8
Results	9
Discussion	15
LYNX PELT MEASUREMENTS	18
Introduction	18
Methods	19
Results	19
Discussion	23
SNOWSHOE HARE CYCLE	24
Introduction	24
Methods	24
Results	25
Discussion	28
MACKENZIE BISON SANCTUARY LYNX STUDY	29
Introduction	29
Study Area	32
Methods	34
Results	36
Trapping Success	36
Track Counts	39
Radio-telemetry	39
Discussion	40
ACKNOWLEDGEMENTS	41
PERSONAL COMMUNICATIONS	43
LITERATURE CITED	44



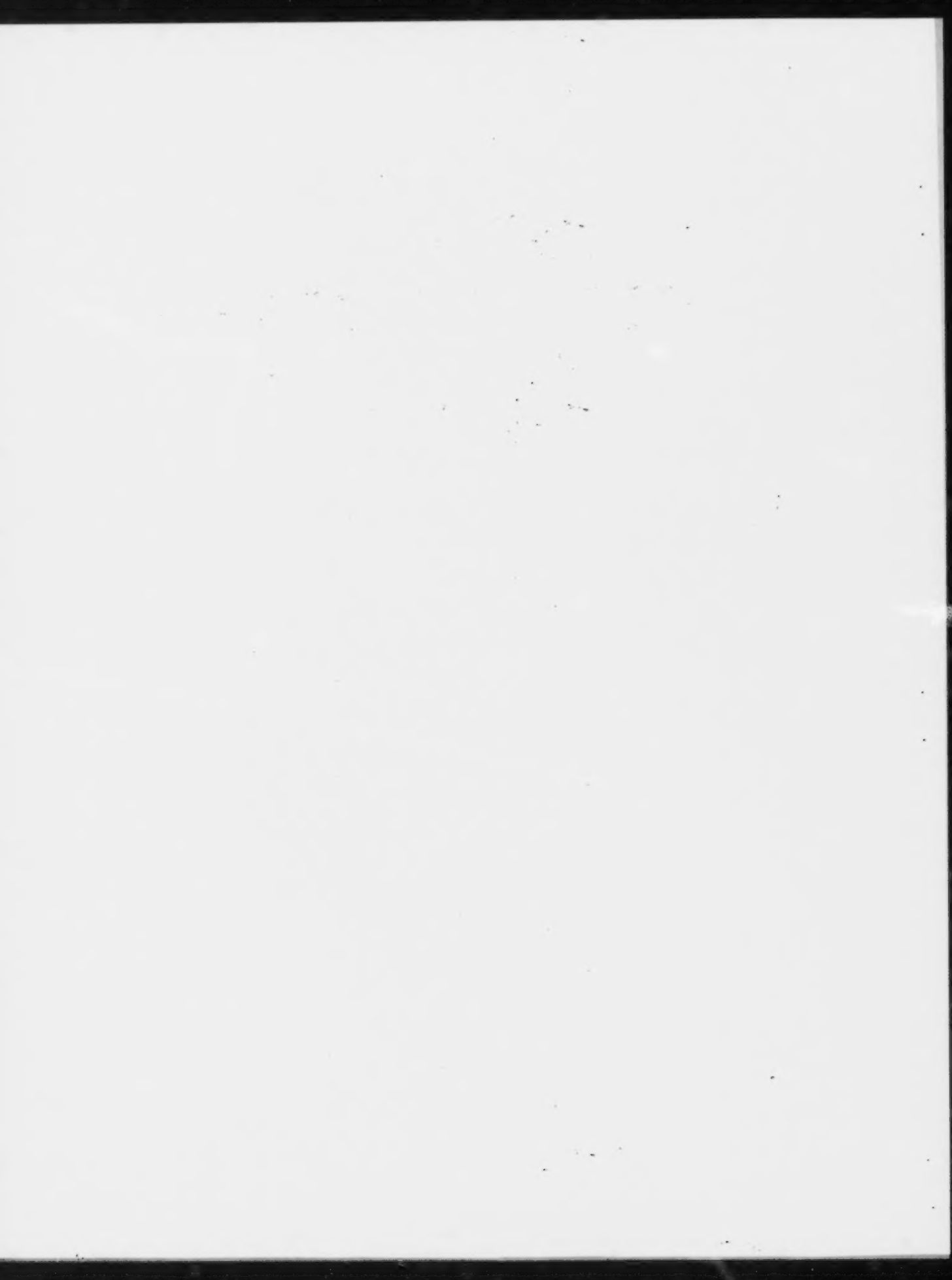
LIST OF FIGURES

Figure 1.	Lynx harvest (Fig. 1a) and average pelt price (Fig. 1b) for the NWT, 1957-58 to 1987-88	5
Figure 2.	Age and sex of lynx carcass examined during 1988-89 (n=181)	11
Figure 3.	Location of the Sanctuary lynx study	33



LIST OF TABLES

Table 1.	NWT lynx harvest from fur returns for 1986-87 and 1987-88	4
Table 2.	Proportion of kittens, yearlings and adults (2+ years), and sex ratio in lynx carcasses examined during the 1988-89 season	10
Table 3.	Pelt length (nose to base of tail) and width (widest part of the pelt, from skin edge) for lynx carcasses collected 1988-89, NWT	12
Table 4.	Kidney fat index (KFI) and xiphoid fat weight by age class and by month of capture (kittens excluded)	14
Table 5.	Number of recent placental scars (RPS) by age class, 1988-89	15
Table 6.	Proportion of lynx kittens in the harvest from 1985-86 to 1987-88, based on ≤ 84 cm pelt length, and in 1988-89 based on ≤ 89 cm pelt length	20
Table 7.	Percent lynx kittens by month in pelts measured during 1988-89 based on ≤ 89 cm pelt length	22
Table 8.	Hare track count summaries conducted during 1988-89	26
Table 9.	Snowshoe hare pellet counts, 1988 and 1989	27
Table 10.	Lynx captured at the Sanctuary lynx study area, 6 March - 28 June 1989.	38



INTRODUCTION

Lynx (Lynx canadensis) are an important furbearer in the Northwest Territories (NWT), ranking second only to marten (Martes americana) in value to northern trappers. While populations of lynx in the NWT generally appear to be stable within the fluctuations of an approximate 10-year cycle, information from many jurisdictions south of 60°N suggests that population trends in these areas are decreasing. Given these factors, it is imperative that NWT lynx populations be monitored closely and managed wisely. This annual report will summarize lynx harvest trends, and management and research programs conducted during the past year. It is hoped that this report will be of use to Department of Renewable Resources (DRR) staff, trappers, and other parties interested in responsible use and management of lynx in the NWT.

The following areas of study will be covered:

1. Harvest trends.
2. Carcass collections conducted primarily to:
 - a) correlate age to pelt measurements,
 - b) determine the age and sex ratios in the harvest, and
 - c) provide body and reproductive condition indices.
3. Pelt measurements to determine the proportion of kits in the harvest.
4. Snowshoe hare (Lepus americanus) pellet counts to index the hare cycle.

5. Mackenzie Bison Sanctuary lynx study, primarily concerned with examining habitat use, home range size and dispersal patterns during a period of declining and low hare densities.

LYNX HARVEST

During 1987-88, 514 out of 3000 trappers in the NWT sold lynx pelts, and harvested 2037 pelts worth \$794,000. This harvest was up 25% over the previous year. The greatest harvest was concentrated in the southern Mackenzie Valley and Great Slave Lake area (Table 1). Figures for the 1988-89 season are not yet available, but indications are that there will be a substantial increase in the harvest.

The pattern of lynx harvest in the NWT since the late 1950s (Fig. 1) has generally followed the 10-year cycle described for most populations (Elton and Nicholson 1942, Keith 1963). Although lynx harvests generally follow this cycle within regions, all regions do not appear to cycle in phase. Harvests in the western portions of the NWT appear to peak 2 or 3 years after high harvests in the Great Slave Lake region (K. Poole unpubl. data).

The average price of a lynx pelt jumped considerably during the late 1970s and increased again in the mid-1980s to peak at \$616 in the 1985-86 season (Fig. 1). The average pelt price for the 1987-88 season was \$390. Lynx pelt prices dropped 15-20% during 1988-89.

The trend over the past several years suggests that NWT lynx harvests are approaching a peak, as has characteristically occurred around the turn of every decade. What remains to be seen is whether or not the harvest will reach 4,000-5,000 pelts

Table 1. NWT lynx harvest from fur returns for 1986-87 and 1987-88.

<u>Community</u>	<u>1986-87</u>	<u>1987-88</u>	<u>% Change</u>
Aklavik	7	10	+ 43
Arctic Red R.	9	5	- 44
Ft. Franklin	5	19	+280
Ft. Good Hope	49	19	- 41
Ft. McPherson	25	7	- 72
Ft. Norman, N Wells	31	26	- 16
Inuvik	31	21	- 32
Tuktoyaktuk	1	9	+900
Dettah	8	3	- 63
Ft. Liard	92	144	+ 57
Ft. Providence	149	239	+ 60
Ft. Rae	168	161	- 4
Ft. Resolution	200	255	+ 28
Ft. Simpson	146	232	+ 59
Ft. Smith	314	435	+ 39
Hay River	38	110	+189
Jean Marie R.	6	10	+ 67
Kakisa L.	11	26	+136
Lac La Martre	32	20	- 38
Nahanni Butte	46	54	+ 17
Pine Point	23	20	- 13
Rae Lakes	7	3	- 57
Snare L.	1	1	0
Snowdrift	12	31	+158
Trout L.	70	64	- 9
Yellowknife	116	86	- 26
Wrigley	31	21	- 32
Tungsten	3	0	-
Alta/Sask Trappers	3	6	-
Total NWT	1634	2037	+ 25

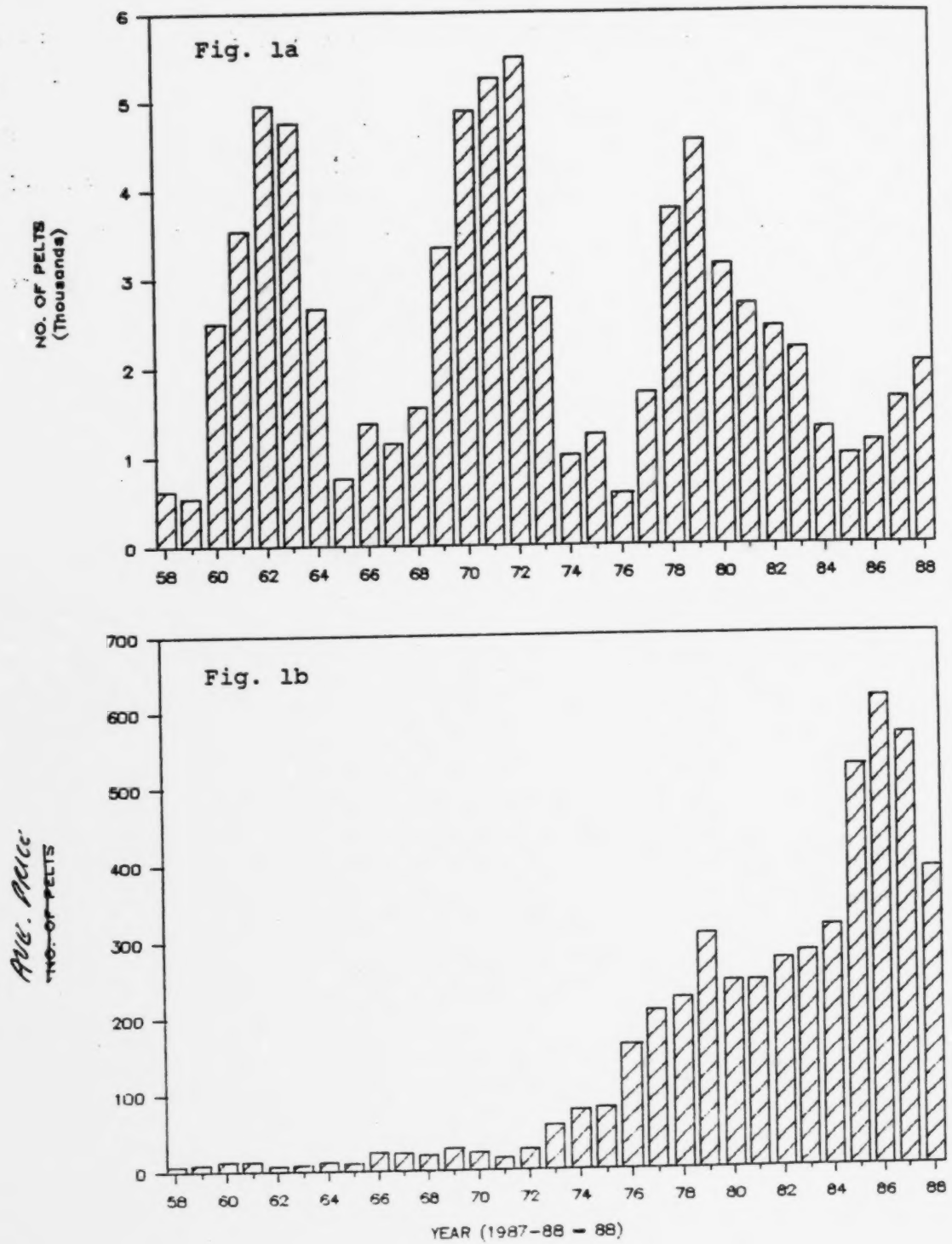


Figure 1. Lynx harvest (Fig. 1a) and average pelt price (Fig. 1b) for the NWT, 1957-58 to 1987-88.

annually, as has occurred in recent peaks (Fig. 1). The five-year harvest centred around the cyclic peak in 1979-80 was 23% lower than the previous peak centred around 1970-71, even though pelt prices, and presumably trapper effort, were considerably higher. Perhaps of more concern is an 11% increase in harvest during the cyclic low in the mid-1980s compared with the previous decade. Again, assuming that trapper effort was greater because of high pelt prices (mean of \$506 in the mid-1980s compared with \$132 in the mid-1970s), this increase in harvest may indicate a higher harvest rate rather than higher lynx populations. A lower overall peak harvest in the present cyclic high may result from this increased effort during the low in the lynx population.

Harvest densities during 1987-88 for the southern Mackenzie as a whole averaged 0.73 lynx/100 km², and for Ft. Smith (a representative community) 1.80 lynx/100 km². Quinn and Thompson (1987) classified harvest densities in Ontario of 0.34, 0.70 and 1.71 lynx/100 km² as low, medium and high densities, respectively.

CARCASS COLLECTIONS

Introduction

An examination of lynx carcasses donated by trappers from four communities in the NWT was initiated in the 1988-89 season. The purpose of this collection was several-fold:

1. Pelt measurements are used in many jurisdictions to obtain accurately and rapidly an indication of the proportion of kittens in the harvest. Kit production and survival varies greatly over a complete cycle, with few or no kits produced or surviving during periods of low hare densities. The proportion of kits in the harvest varies from as low as 3% at cyclic lows to 30% in increasing populations (Brand and Keith 1979, O'Connor 1984). Examination of the proportion of kits in the harvest will provide an indication of where the lynx cycle is in a particular area, and of lynx productivity during the summer prior to harvest. This information is valuable in interpreting harvest trends and making management decisions to maximize harvest return.

In the past, the pelt length used to assign kit status in the NWT was ≤ 84 cm (33 in), while Yukon and Alaska use ≤ 89 cm (35 in). Use of the NWT criteria may result in the misclassification of a substantial number of kittens, and may not accurately reflect the actual proportion of kits in

- the harvest. Pelt lengths from known-age animals will enable determination of the most accurate dividing point.
2. Age and sex ratios of lynx in the harvest will provide an indication of which segments of the population are harvested during various parts of the season. This information would be useful if, for example, trappers wished to decrease pressure on adult females during a low in the hare cycle.
 3. Examination of carcasses will provide a comparison of lynx body condition and reproductive rates among various areas in the north, and will provide an indication of what stage we are at in the lynx cycle.

Methods

With the assistance of DRR field staff in Fts. Providence, Smith and Simpson, cooperative trappers with a history of high lynx harvests were provided with paired number tags, and were asked to affix one tag to the carcass and one to the pelt, noting location and date taken. Pelt length (tip of the nose to base of the tail) and pelt width (widest part of the pelt, from skin edge) was measured on dried pelts by DRR staff or the trapper prior to shipment to auction. Trappers were asked to turn in their entire season's catch so that the complete chronology of age and sex over the trapping season would be obtained.

The carcasses were examined in Yellowknife, documenting body and tail lengths and chest girth, weight, sex and reproductive

condition (uteri soaked overnight in water, uterine horns split and examined macroscopically over a light source for placental scars or fetuses), and fat indices (weight of xiphoid [sternal] fat, and perirenal fat indexed to kidney weight) (Brand and Keith 1979, Stephenson 1986). Ovaries were examined from a sample of females, but this was not continued because of the difficulty in reliably segregating luteal bodies (Brand and Keith 1979, Quinn and Thompson 1987). Stomach contents, where present, were collected for later examination. Age was determined by tooth development and incomplete closure of apical canine root foramen (kittens) (Saunders 1964) or by standard cementum aging (conducted by Matson's Laboratory, Milltown, MT) (Crowe 1972, Brand and Keith 1979). Age class "0" (kit) denotes a lynx in its first winter of life; a yearling (in its second winter of life) is designated by age class "1". Differences among data sets were considered significant when $P \leq 0.05$.

Results

A total of 181 lynx carcasses were examined during the 1988-89 season: Ft. Simpson - 74 from 7 trappers; Ft. Providence - 64 from 6 trappers; Ft. Smith - 39 from 3 trappers; and Yellowknife - 4 from 1 trapper. Kittens made up 28.7% of the sample, with more kittens harvested later in the season (Table 2). Yearlings dominated the sample overall (55.8%). Their proportion in the harvest decreased as the season progressed. Mean age (kit=0,

Table 2. Proportion of kittens, yearlings and adults (2+ years), and sex ratio in lynx carcasses examined during the 1988-89 season.

	Month Trapped (% total)					Total
	Nov.	Dec.	Jan.	Feb.	Mar.	
Sample size	27	42	54	38	20	181
<u>Age Class</u>						
Kitten	3.7	9.5	31.5	42.1	70.0	28.7
Yearling	77.8	73.8	53.7	44.7	15.0	55.8
Adult	18.5	16.7	14.8	13.2	15.0	15.5
<u>Sex Ratio</u>						
M:F	74:26	69:31	46:54	61:39	45:55	59:41

yearling=1, etc.) of the harvest was 1.19. Most (58.6%) of the lynx examined were males ($P=0.02$), with predominantly more males taken in November and December (71%) than after 1 January (51%) (Table 2). The age of animals in the collection was heavily skewed towards the 0-1 year age classes (Fig. 2).

Pelt lengths paired to carcasses were available for 107 lynx (Table 3). Pelt length was plotted by age class (kits v. older) to determine the best length to estimate the proportion of kittens in the population. Using ≤ 89 cm, 71% of the kits would be correctly classified and about 3% of the adults would be incorrectly classified as kittens. At ≤ 90 cm these proportions change to 71% and 6%, respectively. Using ≤ 91 cm would result in accurately classifying 88% of the kits, misclassifying four kits as adults, but 8% (six animals) of the adults would be

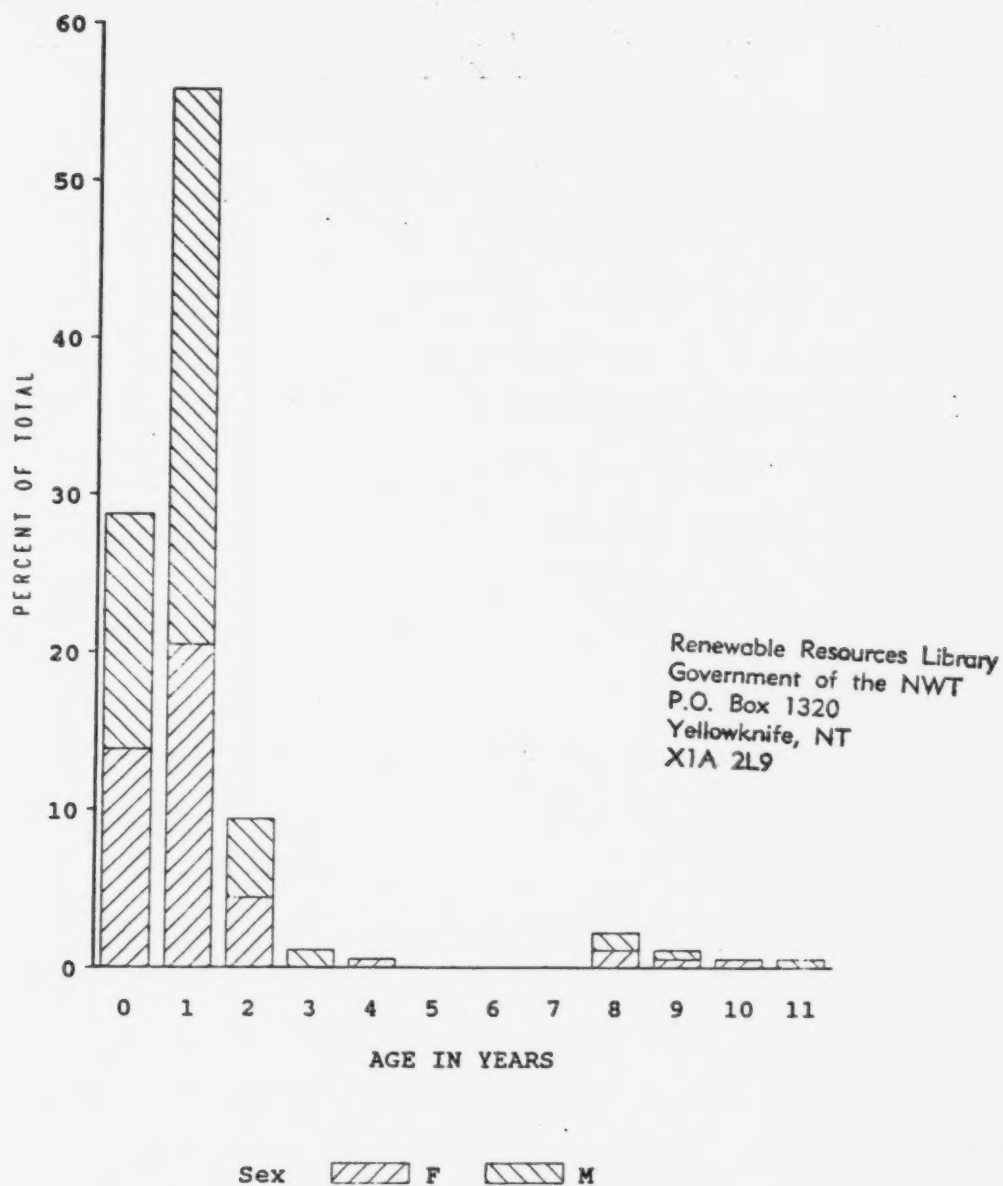


Figure 2. Age and sex of lynx carcass examined during 1988-89 (n=181).

Table 3. Pelt length (nose to base of tail) and width (widest part of the pelt, from skin edge) for lynx carcasses collected 1988-89, NWT.

Age Class	Sample Size	Mean (cm)	Minimum (cm)	Maximum (cm)	SD
Pelt Length					
Kitten	34	84.9	70.0	96.5	6.87
Adult (1+ years)	73	101.5	89.0	119.0	6.35
Pelt Width					
Kitten	32	19.3	16.5	23.0	1.85
Adult (1+ years)	68	21.5	17.0	27.9	2.01

classified as kittens. Given the relatively large proportion of adults in the harvest, especially during the cyclic low, a large error in misclassifying adults could seriously overestimate the actual proportion of kittens in the harvest.

At first glance 90 cm may appear to be the most likely division between the age classes. However, 7 of the 10 kitten pelts measuring ≥ 90 cm were taken from only 1 of the 17 trappers submitting carcasses. If this trapper tended to stretch his pelts more than others, placing too much weight on his pelts may bias the dividing point too high. When this trapper was removed from the analysis, ≤ 89 cm became the most accurate dividing point, with three kits misidentified as adults, and two adults

labelled as kits. More collections will take place in the next 2-3 years that will hopefully clarify this situation. For the present, ≤ 89 cm will be used to estimate the proportion of kittens in the harvest.

Date caught had some impact on pelt length. The three longest kitten pelts were all taken in March during the last two weeks of the season.

Pelt width was recorded for 100 of the lynx, in an effort to further refine differentiation of age classes from pelts (Table 3). Although the average width of kitten pelts was about 2 cm less than for older animals, overlap was so large that it appears to be of limited use. Discriminant function analysis (SAS 1988, DISCRIM) proved less accurate in assigning age class to lynx within the sample when pelt length and width was considered, than when length alone was used.

Both xiphoid fat and kidney fat indices (KFI) were available for 161 carcasses. The correlation between the two indices was strong ($r=0.90$, $P<0.0001$); however, xiphoid fat decreased to zero (no visible xiphoid) before the KFI reached its lower levels (minimum 3.3). Thus, in all but the leanest lynx both measurements provided comparable indices of body condition.

KFI was similar among the first three age classes, and increased greatly with older animals (Table 4). The weight of xiphoid fat was low in kittens, increased in yearlings and 2-year-olds, and was highest in the 3+ age class. No pattern to variations in fat indices by month of capture (kits excluded) was

Table 4. Kidney fat index (KFI) and xiphoid fat weight by age class and by month of capture (kittens excluded).

Age Class	Kidney Fat Index			Xiphoid Fat (g)		
	<u>n</u>	<u>Mean</u>	<u>SD</u>	<u>n</u>	<u>Mean</u>	<u>SD</u>
0	46	16.2	9.03	51	1.9	3.55
1	93	18.2	12.68	98	10.5	10.74
2	16	17.1	15.45	16	10.7	15.34
3+	10	44.8	30.08	11	38.3	25.20
<u>Month</u>						
Nov.	23	18.8	10.58	25	14.3	13.92
Dec.	35	22.5	19.56	38	14.1	17.74
Jan.	35	13.2	7.54	35	6.7	7.21
Feb.	22	30.6	22.31	22	20.9	18.49
Mar.	4	14.4	16.29	5	6.2	11.17

detected. No difference was detected in KFI among the three main collection communities (ANOVA, $P=0.9$).

The number of young produced in the spring of 1988, as determined by counts of recent placental scars, varied with age (Table 5). Over 77% of all yearlings bred in their first year. Mean placental scar counts (1+ years) differed significantly among communities (ANOVA, $P=0.03$), with Ft. Smith having a lower mean (2.23 scars) than Fts. Providence (4.14) and Simpson (3.95).

Table 5. Number of recent placental scars (RPS) by age class, 1988-89.

Age Class	n	% 0 RPS	Mean No. RPS	Mean No. RPS Excluding 0s	Max. RPS	Min. RPS
0	25	100	0	0	-	-
1	35	23	3.3	4.2	6	2
2+	12	8	4.3	4.5	7	2

Discussion

The 89 cm (35 in) criteria to differentiate pelts from kits and adults is currently used by the Yukon (Ward and Slough 1987), British Columbia (Archibald pers. comm.) and Alberta (Neumann pers. comm.). Alaska uses 34 in (86.5 cm) (Melchior pers. comm.). It is unclear whether the shorter kit pelts from Ontario (Quinn and Gardner 1984) are a result of smaller lynx or different stretching techniques. Pelt width appears to have limited value in differentiating age classes because of the large overlap between age classes, and will be dropped in future. Alaska has also concluded that pelt width is not worth recording (Stephenson pers. comm.).

The age and sex ratios reported for this sample compare well with other studies conducted during years with increasing or high hare densities. Brand and Keith (1979) found 31% kittens and 54%

yearlings in a sample of Alberta lynx carcasses, while in an Ontario study Quinn and Thompson (1987) found 19% and 53%, respectively. At times of declining or low hare densities the proportion of kits in the harvest decreased to zero or nearly zero (Brand and Keith 1979, Parker et al. 1983). The within season shift in the proportion of each age class in the harvest also compares closely with the Ontario study, with the proportion of yearlings decreasing and kits increasing as the season progresses (Quinn and Thompson 1985).

The sex ratio biased to males in the NWT collection also parallels findings of other researchers, probably a result of differential trapping vulnerability (Bailey et al. 1986, Quinn and Thompson 1987).

The missing cohorts in the 5-7 year age classes likely indicate that few kittens were produced or survived in spring 1981-83, a period when hares may have been at their cyclic low. Early spring 1981 corresponds with the second winter after the peak lynx harvest of the last cyclic high in 1978-79.

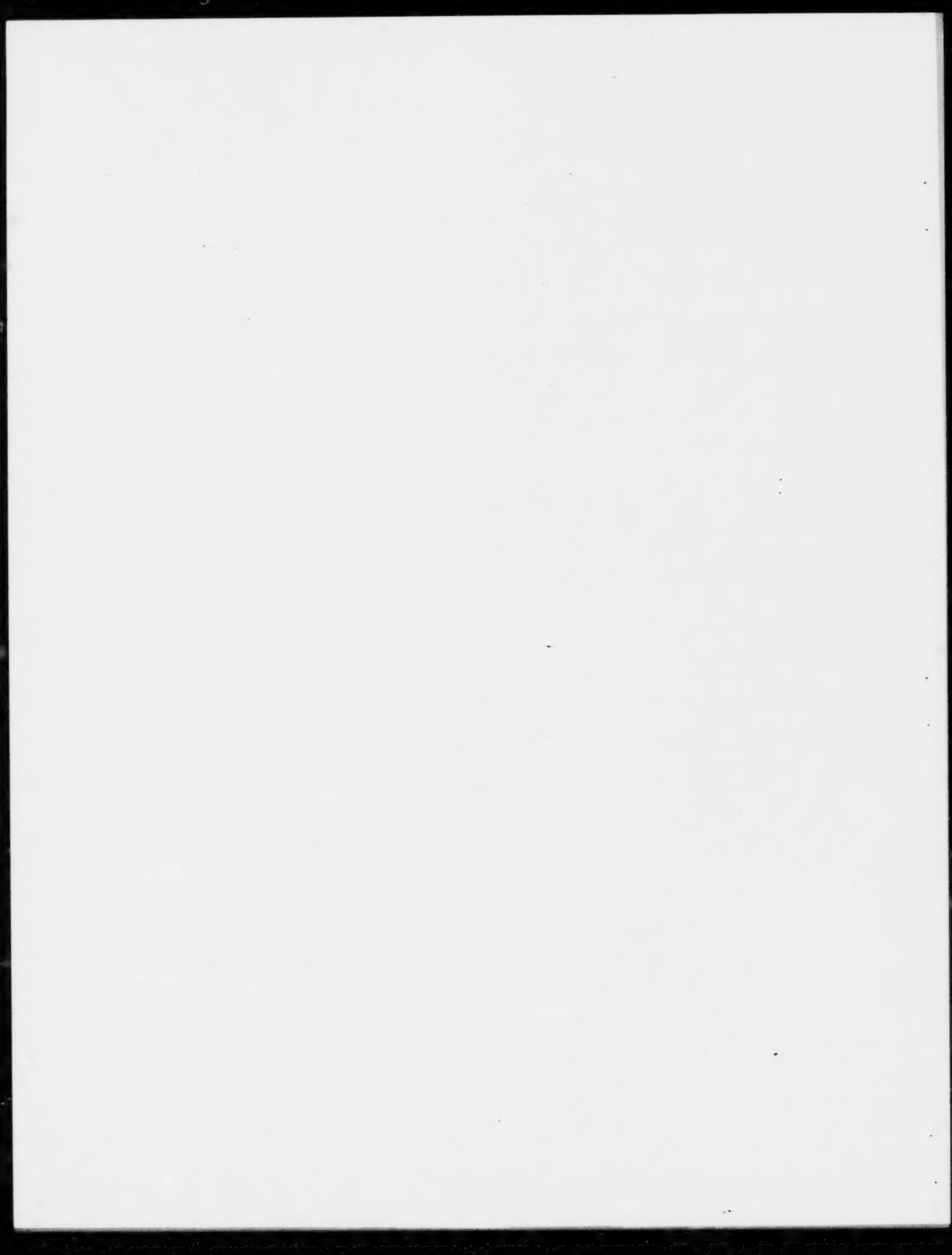
Data from the condition indices must be interpreted with caution. Virtually all lynx are taken in leghold traps, and almost all animals are found alive in the trap, even in cold conditions and for periods of up to 7 days or longer between trap checks. Thus fat reserves will be influenced by length of time in the trap and weather conditions.

The high proportion of yearlings with recent placental scars (77%) indicates high productivity and high hare densities.

Parker et al. (1983) found that during a decline in hare density the proportion of yearlings with scars decreased from 67% to 0%, and O'Connor (1984) found 69% and 7% of yearlings had placental scars at high and low hare densities, respectively.

The lower placental scar count from the Ft. Smith area may indicate that productivity there is on the decrease. Supporting this suggestion is the fact that there were slightly fewer kits in the harvest in Ft. Smith (25%) as compared to Fts. Providence and Simpson (28-29%) (see Pelt Measurements).

Evidence from the proportion of kits, and fat and reproductive indices suggest that hare densities are high and lynx numbers are likely increasing in most areas in the southern Mackenzie. Carcass collections will continue over the next 2-3 years to monitor these parameters further.



LYNX PELT MEASUREMENTS

Introduction

As noted in the previous section, the proportion of lynx kittens in the population, as reflected in the harvest, fluctuates widely over the 10 year lynx cycle. Peaks in the proportion of kits in the harvest generally occur before lynx populations and harvests peak (O'Connor 1984). Thus, a decrease in kits in the harvest should precede a decrease in actual lynx populations. Many studies stress the importance of curtailment of trapping during the cyclic low (tracking harvest strategy [Caughley 1977]), to ensure that sufficient numbers of adults remain as seed stock to begin the cyclic increase (Brand and Keith 1979, Todd 1983, Hatler 1988). Monitoring of the proportion of kits in the harvest will enable trappers to identify when lynx production has fallen off, a period when they may wish to decrease trapping pressure.

Quinn and Gardner (1984) pointed out that pelt size is useful for distinguishing kits from older animals. Many jurisdictions in North America now routinely measure pelts prior to shipment to auction, to estimate the proportion of kits in the harvest. This section reports on lynx pelt measurements taken in the NWT over the past four trapping seasons.

Methods

Measurement of lynx pelt length (tip of nose to base of tail) was initiated in the NWT during the 1985-86 season. The pelt length used to assign kit status was ≤ 84 cm (33 in), modified from the results of an Ontario lynx study (Quinn and Gardner 1984). DRR staff in all communities were asked to measure pelts prior to shipment to auction and record the number of "kits" in each shipment. Beginning in the 1988-89 season, officers were asked to record all pelt measurements (pelt length and width [widest part of pelt from skin edge], and sex) so that once the most reliable dividing point to separate age classes is determined (see Carcass Collections), the proportion of kits in the harvest may be estimated retrospectively.

Results

Prior to the 1988-89 season, the number of pelts ≤ 84 cm was recorded (Table 6). Total percent "kits" decreased from 16.7% to 10.0%, then increased to 16.4% in the 1987-88 season. During the 1988-89 season, carcass collections matched with pelt measurements indicated that ≤ 89 cm (35 in) may be the most reliable length to determine the proportion of kits in the harvest from pelt measurements (see Carcass Collections). Using 89 cm, of 1721 lynx pelts that were measured during the 1988-89

Table 6. Proportion of lynx kittens in the harvest from 1985-86 to 1987-88, based on ≤ 84 cm pelt length, and in 1988-89 based on ≤ 89 cm pelt length.

DRR Station	Season							
	1985-86		1986-87		1987-88		1988-89	
	<u>n</u>	<u>%Kits</u>	<u>n</u>	<u>%Kits</u>	<u>n</u>	<u>%Kits</u>	<u>n</u>	<u>%Kits</u>
Tuktoyaktuk	-	-	-	-	5	40	-	-
Aklavik	22	9	7	0	10	40	8	38
Inuvik	6	50	32	9	23	26	-	-
Ft. McPherson	22	41	-	-	2	50	8	38
Ft. Good Hope	27	11	47	17	15	13	19	26
Ft. Franklin	4	0	6	0	13	31	17	24
Ft. Norman	24	0	18	17	-	-	33	27
Norman Wells	-	-	-	-	9	33	-	-
Ft. Simpson	74	23	112	8	161	11	318	29
Ft. Liard	110	6	191	9	229	13	276	21
Trout Lake	-	-	-	-	-	-	24	19
Ft. Providence	26	12	72	4	-	-	247	28
Ft. Rae	32	3	65	3	31	29	28	46
Yellowknife	23	57	-	-	61	16	89	19
Hay River	48	25	-	-	-	-	258	28
Pine Point	21	19	58	26	-	-	-	-
Ft. Resolution	27	7	-	-	-	-	-	-
Year Total (at ≤ 84 cm)	539	16.7	608	10.0	764	16.4	1721	
Year Total (converted to ≤ 89 cm: see text)		26.7		16.1		26.2		25.9

season, almost 26% were kits (Table 6). Where sample sizes were large ($n > 50$), the proportion ranged from 19.1 - 28.6% of the harvest.

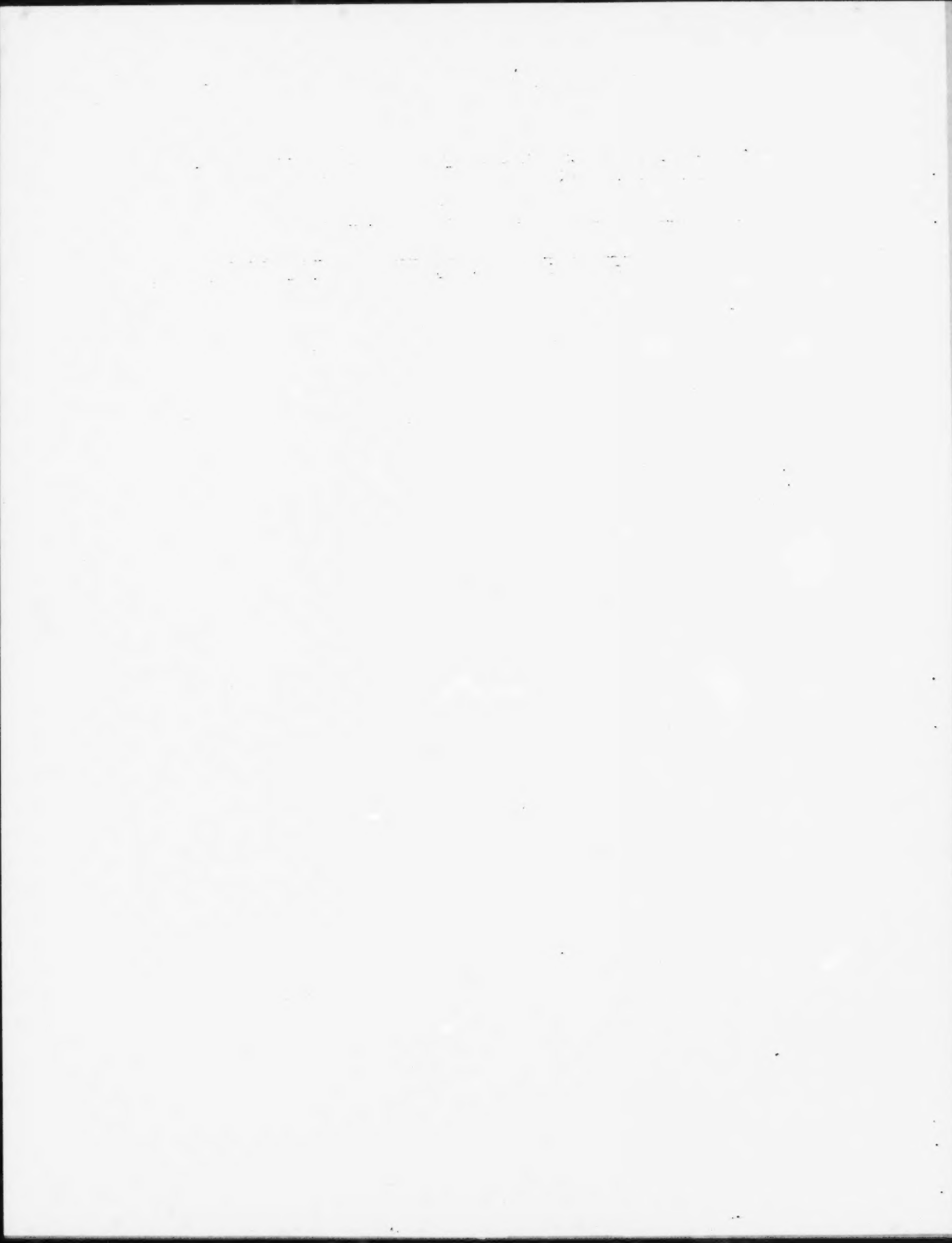
The 1988-89 pelt measurements showed a general trend in the timing of when kits were caught. The proportion of kits in the harvest increased from 14% before Christmas, to 25% during January, to 40% in pelts measured in February, March and April (Table 7). This pattern emphasizes the need to measure pelts consistently throughout the season; samples examined only late in the winter will always show a much larger proportion of kits in the harvest than occurs over the entire season.

Males comprised 60% of the 1141 pelts for which sex was recorded. Although this figure is consistent with normal harvests and the sex ratio found in the collection (59%), there may be some difficulty in determining sex of some pelts, possibly resulting in biased reporting rendering this figure questionable. Similarly, pelt width varied greatly with a large amount of overlap between age classes.

Table 7. Percent lynx kittens by month in pelts measured during 1988-89 based on ≤ 89 cm pelt length.

	Month ¹						<u>Total</u>
	<u>Nov.</u>	<u>Dec.</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	
Sample Size	101	610	388	301	277	44	1721
% Kittens	8.9	14.8	24.7	40.2	38.6	52.3	25.9

¹ Note that month corresponds to date measured at the DRR office upon receipt from the trapper. The delay between trapping a lynx and pelt measurement generally spans several days to several weeks.



Discussion

The high proportion of kits in the 1988-89 harvest means that lynx production (number of kits per litter and survival of kits) was good last year across much of the western NWT, and that snowshoe hare densities were likely high at least until midway through this past winter. Hay River, Ft. Providence and Ft. Simpson all had proportions approaching the maximum reported (Brand and Keith 1979).

Because only the number of pelts ≤ 84 cm had been counted in the past, and not all pelt measurements recorded, it is difficult to compare data among years. If I assume the ratio of pelts ≤ 89 cm to pelts ≤ 84 cm found in this past winter's sample is consistent, then multiplying previous estimates of kits in the harvest by 1.6 should approximate the 89 cm measurements. Given this conversion, the proportion of kits in the harvest in 1987-88 is similar to this past season (about 26%), up from 16% in 1986-87 (Table 6). This population trend agrees with what I have heard in discussions with officers and trappers, and harvest returns over the past three years. I am suspicious of the 1985-86 figures; these proportions are much too high for a period when the lynx cycle was at a low.

SNOWSHOE HARE CYCLE

Introduction

Lynx populations cycle directly with population levels of their main prey, the snowshoe hare (Brand et al. 1976). When hare populations drop dramatically, lynx reproduction is depressed and kitten survival declines, resulting in greatly lowered recruitment (Nellis et al. 1972, Brand and Keith 1979, O'Connor 1984). Lynx populations generally peak 1-2 years after the hare peak (Brand and Keith 1979, O'Connor 1984). Given the importance of hares to lynx populations, hare populations are being indexed in several areas of the southern Mackenzie. This monitoring will be useful in predicting decreases in lynx populations, and to assist in interpreting trends in lynx population parameters and harvests.

Methods

Two methods were used to index hare populations in the NWT. Track counts were conducted during the winter in selected locations to index the number of hares in a given area (Thompson et al. 1989). Counts were conducted along 1 km transects 24-72 hours after snowfall. Track counts are expressed as tracks/km-day (km travelled X days since last snowfall). Runways were

assigned seven tracks for calculation purposes (Ward and Slough 1987).

As a second index to the hare cycle, and one that will provide actual hare density estimates, 70-100 faecal pellet plots have been established near Yellowknife, the Mackenzie Bison Sanctuary, Ft. Smith, Norman Wells and Inuvik. The technique follows those outlined in Krebs et al. (1987). Briefly, in June 1988 2-inch X 10-foot plots (using 2-inch-wide stakes) spaced at 25-m intervals were set up on 4-6 transects in each area. In June of 1988 and 1989, all faecal pellets on plots were counted and removed. These counts provide an assessment of actual hare density over the preceding year. An estimate of hare density may be derived from the formula from Krebs et al. (1987):

$$\text{Mean hares/hectare} = 0.27(\text{Mean No. Pellets}) + 0.42$$

The transects were placed in several representative habitat types in each area in rough proportion to their availability. Satellite imagery was used in selecting habitat types and transect locations.

Results

Renewable Resources Library
Government of the NWT
P.O. Box 1320
Yellowknife, NT
X1A 2L9

Track counts were conducted in the Mackenzie Bison Sanctuary lynx study area in November 1988 and March 1989, and in the Norman Wells area in December 1988 (Table 8). Counts decreased in the Sanctuary during the winter, and were

Table 8. Hare track count summaries conducted during 1988-89.

<u>Location</u>	<u>Date</u>	<u>No. Transects</u>	<u>Mean Tracks/ km-day</u>	<u>SD</u>
Norman Wells	Dec 88	15	23.0	17.6
Sanctuary	Nov 88	9	228.8	110.0
	Mar 89	9	105.0	55.2

substantially higher there than in the Norman Wells area.

The number of hare pellets cleared from plots in June 1988 were counted, but it was impossible to determine with certainty which pellets had been deposited in the last year. These data are presented as an indication of relative hare densities among areas (Table 9). Counts conducted in June 1989 better represent actual hare densities in the areas over the past year (Table 9). Hare densities for 1988-89 were highest in the Sanctuary, with densities along some transects reaching 5 hares/ha. Yellowknife, Norman Wells and Ft. Smith appear to have comparable hare densities. It is noteworthy that the June 1989 pellet counts at Norman Wells and Inuvik were greater than the counts 1 year previously, while the counts in Ft. Smith, and especially Yellowknife had decreased over the initial clearing. The 1989 counts in the Sanctuary decreased slightly but remained high.

Table 9. Snowshoe hare pellet counts, 1988 and 1989.

Area/Transect	No Plots	No. of Pellets ¹				1989 Mean Hares /Ha	Main Vegetation ² Type
		June 1988		June 1989			
		Mean	SD	Mean	SD		
YELLOWKNIFE							
All	70	9.3	8.7	5.3	6.2	1.9	
1	20	6.9	6.1	4.2	4.4	1.6	wet sp wil
2	5	11.8	5.0	6.6	5.0	2.2	wet sp mix
3	15	10.6	7.2	6.0	6.4	2.0	mix wet
4	10	19.4	12.5	10.0	8.4	3.1	mix wet
5	10	6.8	8.1	5.9	7.0	2.0	wet sp mix
6	10	3.6	2.7	0.4	0.7	0.5	open sp
FORT SMITH							
All	80	5.8	10.3	5.0	9.6	1.8	
1	20	5.2	6.6	4.5	4.5	1.6	open sp pi
2	20	1.5	1.9	2.4	2.4	1.1	open pi sp
3	20	0.4	0.8	0.6	0.8	0.6	mature asp
4	20	16.1	15.1	12.5	16.5	3.8	dense sp bu
NORMAN WELLS							
All	80	2.3	3.2	4.1	5.9	1.5	
1	20	1.6	2.0	1.2	1.7	0.7	dense sp
2	20	3.1	4.8	8.2	9.5	2.6	wil ald
3	20	2.6	3.4	2.2	2.9	1.0	sp moss
4	20	2.1	1.8	4.7	3.8	1.7	sp tam
MACKENZIE SANCTUARY							
All	100	12.9	12.2	10.7	10.5	3.3	
1	20	1.1	1.7	0.6	1.2	0.6	asp mix
2	20	17.0	10.4	16.9	10.6	5.0	dense sp bu
3	20	18.0	16.9	14.9	11.4	4.4	dense sp mix
4	20	10.3	7.9	6.7	3.8	2.2	open sp mix
5	20	18.4	9.2	14.4	11.2	4.3	dense sp bu
INUVIK							
All	101	0.2	0.7	0.9	3.1	0.7	
1	22	0	-	0	-	0	sp mix
2	22	0	-	0	-	0	birch sp
3	20	0	-	0.2	0.7	0.5	bu. alder
4	20	0	-	0	-	0	bu, mix
5	17	1.0	1.5	5.2	6.0	1.8	dense mix

¹ The number of pellets counted in 1988 reflect all pellets taken from the plots.

² Vegetation abbreviations: sp - spruce; pi - pine; asp - aspen; bu - old burn; tam - tamarack; wil - willow; mix - mixed species.

Discussion

The hare data presented may be interpreted as follows: hare densities in the Norman Wells and Inuvik areas have increased rapidly in the previous year, while populations in Ft. Smith and the Sanctuary have stabilized somewhat, and numbers in the Yellowknife area have decreased but remain moderately high. This interpretation lends support to evidence that lynx populations (following the hare cycle) peak 2-3 years later along the Mackenzie Valley than in the Great Slave Lake area. More years of data are required to see how the overall pattern develops.

The highest densities estimated for hares in the NWT over 1988-89 from a formula used by Krebs et al. (1987) are 3-5 hares/ha (300-500/100 ha). Other researchers have reported that hare densities vary from 6-30/100 ha at lows in the cycle to 1000-1300 hares/100 ha at peak densities in prime habitats (Brand and Keith 1979, Ward and Krebs 1985, Bailey et al. 1986). The densities encountered in the NWT are, therefore, relatively high. Again, more years of monitoring are required to determine whether or not current densities represent peak values.

MACKENZIE BISON SANCTUARY LYNX STUDY

Introduction

Management of lynx has become an important issue in many jurisdictions in Canada. National and international concern has been raised that population trends are declining. Although central to the question of cycling in lynx populations, one aspect of lynx ecology that is poorly understood is the importance of refugia, untrapped reservoirs of habitat, which may be a good source of lynx for traplines and areas where lynx are found at significant densities during the low in the snowshoe hare cycle. Knowledge of size requirements for refugia and the ability to identify habitats used by lynx during periods with low hare numbers will enable development of more effective long-term management strategies for lynx in the NWT.

Lynx population dynamics and subsequent management decisions are affected by population cycling, exploitation rates, and other parameters. Studies by Brand et al. (1976), Brand and Keith (1979), Parker et al. (1983) and others have shown that trapping plays a significant role in the dynamics of lynx populations, as trapping mortality appears to be largely additive to natural causes during all but the decline phase of the cycle. In live-trapping and tagging studies, the death of 55% of marked animals was attributed to trapping mortality (Ward and Krebs 1985). Modelling suggested that a 3-4 year moratorium on trapping

beginning in the second year after a peak harvest will increase the 10-year yield by 39% (Brand and Keith 1979). However, should sufficient reservoirs remain where lynx are untrapped, emigration into depleted, trapped regions may negate the need for harvest curtailment.

Researchers have recently emphasized the importance of refugia to lynx populations (Todd 1983, Ward and Krebs 1985, Bailey et al. 1986, Ward and Slough 1987). Critical to our assessment of refugia is knowledge of home range size throughout the cycle (especially during the low), dispersal patterns during the hare crash, prime denning habitats, and identification of "critical" habitats of importance to lynx when hare densities are at their lowest. No work of this nature has been conducted on lynx in the NWT. The Mackenzie Bison Sanctuary area is ideally suited to such a long-term study: historical lynx harvests are high, the habitat is similar to that found over much of the southern Mackenzie, and the relatively flat landscape simplifies radio-tracking.

This study was developed to examine the importance of refugia to lynx in the NWT. Home range size, distribution, habitat use, and dispersal patterns will be examined. An additional benefit of the study will be a lynx population that is mostly marked, and whose size may be estimated (Koehler 1987, Ward and Slough 1987). Presently, no census methods exist to estimate rapidly lynx population size. Use of track counts in an area of known lynx density will allow us to compare the technique

to actual population size as lynx densities change (c.f. Thompson et al. 1989).

This marked population will also provide the opportunity for examination of reproductive and mortality rates, and kitten survival. Lynx habitat use in the northern boreal forest can be comprehensively addressed, since much of the Sanctuary has been extensively mapped for existing vegetation (Mychasiw and Moore in prep.).

Primary objectives of the study are to:

1. Examine the importance of refugia to lynx, specifically how home range size, distribution, habitat use, and dispersal pattern relate to the size of refugia needed to ensure populations attain normal (i.e., historic) cyclic fluctuations.
2. Examine reproductive and mortality rates of adults, and kitten survival during the high, declining and low phases of the lynx cycle.
3. Determine whether or not track counts can be used to estimate lynx population size.

Study Area

The study is located in the Mackenzie Bison Sanctuary, approximately 50 km northeast of Ft. Providence (Fig. 3). Live-trapping was conducted in an area of approximately 125 km² northeast of the Calais Lake Research Centre, in a portion of Art Look's trapping area. The Sanctuary lies within the Great Slave Plain (Bostock 1964), and is characterized by relatively flat terrain punctuated by large lacustrine depressions (Mychasiw and Moore in prep.). Elevations within the trapping area range from 200-230 m a.s.l. The area receives an average of 280 mm of precipitation annually, with a mean temperature in January of -27.5°C and a July mean of 16.3°C (Canada, Atmospheric Environment Service 1982 [Ft. Providence data]).

According to Rowe (1972), the study area is literally on the border between the Upper Mackenzie Section and the Northwestern Transition Section of the Boreal Forest Region. Vegetation cover types quoted here are from a vegetation study of the Sanctuary by Mychasiw and Moore (in prep.); percent ground cover is taken from satellite imagery. The main cover type is coniferous forest (about 41% of the area), consisting of pine forest community (Jack pine - Pinus banksiana, balsam poplar - Populus balsamifera, and trembling aspen - P. tremuloides dominating the tree canopy), spruce forest community comprising primarily white spruce (Picea glauca) and tamarack (Larix laricina), and mixed

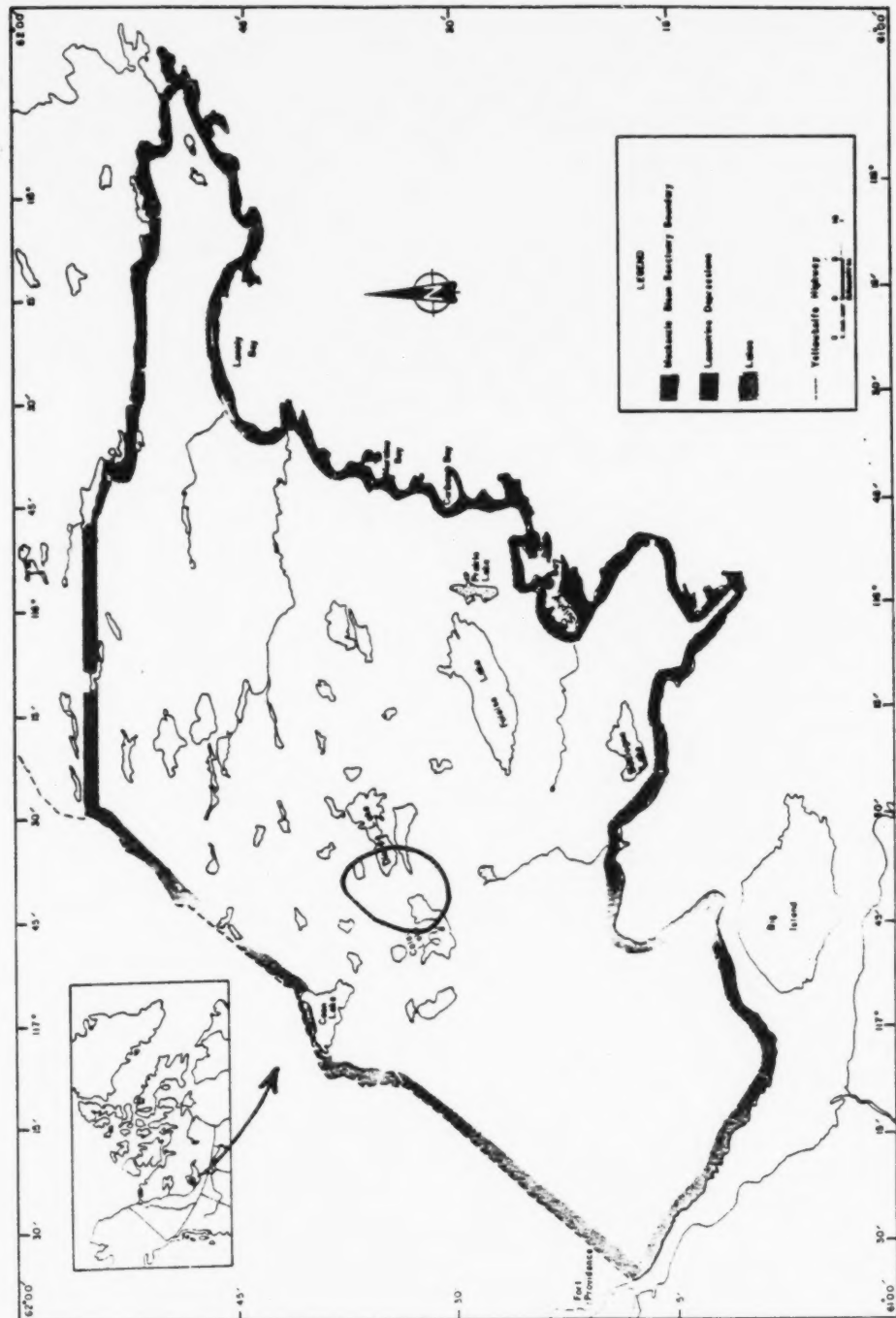


Figure 3. Location of the Sanctuary lynx study (circled).

pine and spruce forests with jack pine and black spruce (P. mariana) dominating. Mixed forest, primarily trembling aspen, occurs in about 14% of the area. Organic terrain (primarily sphagnum peat) and sparsely vegetated areas occupy 10% each of the total ground cover. Sedge meadows (primarily Carex spp.) cover about 8% of the area within larger lacustrine depressions adjacent to the coniferous forest. The remainder of the area (17%) is composed of shrublands and shrub meadows, recent burns, standing water and unclassified areas (Mychasiw and Moore in prep.).

Burns are evident in many areas of the study. Substantial fires have occurred in the Sanctuary five times in the past two decades, burning almost 6% of the area (Mychasiw and Moore in prep.). Much of the thickest habitat, and also densest concentrations of hares, occurs in old burns.

Access into the study area is by snowmobile in the winter, and ATV or helicopter in the summer. Seismic lines and access trails, dating from exploration in the late 1960s, and lakebeds are used for travel within the study area.

Methods

Live-trapping was conducted from 5 March to 4 April 1989. Up to 40 Freemont leg-snares (Freemont Humane Traps, Candle Lake, Sask.), 24 #3 coil Soft-catch traps (Woodstream Corp., Lititz, PA) and 4 model 609.5 box traps (Tomahawk Live Trap Co.,

Tomahawk, WI) were used. Because of the problem of toes freezing, the Soft-catch traps were ultimately used only when overnight temperatures were predicted to be warmer than -15°C . The traps were set in standard open cubby sets, using baits which varied from commercial lures to a homemade mixture of lynx organs, catnip and beaver castor. Visual attractants included flagging tape and bird wings. The traps were checked once daily.

Captured lynx were immobilized using Telazol (A.H. Robins Co., Richmond, VA) administered by blow-gun at a dose of 5-6 mg drug per kg estimated body weight. The lynx were sexed and weighed, and body and tail length, heart girth and neck circumference were measured. A lower incisor (I3) was extracted for aging unless the animal was obviously a kit, and all lynx were ear-tagged with two small numbered tags (Size 3, Style 1005 Monel, National Band & Tag Co., Newport, KY). Radio-collars (MOD-400, Telonics Inc., Mesa, AZ) were attached to all adults and some kittens. Drugged lynx were allowed to recover for about 2 hours in a box trap prior to release.

Collared lynx were located using standard radio-telemetry techniques (Mech 1983) at irregular intervals from the ground during the spring trapping season, and every 2 weeks beginning in mid-April 1989 using fixed wing aircraft (primarily Super Cub). Accuracy of the ground and air locations has not yet been tested. Because of the layout of seismic lines and trails in the study, most ground based locations were from a minimum of three bearings less than 1.5 km from the lynx.

Lynx tracks were counted each day during the trapping session. Track count techniques follow Stephenson (1986) and Ward and Slough (1987). Both T1 - the total number of times any track was intercepted by a transect/trail - and T2 - the number of times an individual lynx track was crossed by an individual transect - were recorded. Track counts were expressed as tracks/km-day (km travelled X days since last snowfall). Using the track counts together with daily movements of collared animals, we were able to estimate the number of lynx residing in the study area in March 1989 (Brand et al. 1976, Ward and Slough 1987).

Snowshoe hare abundance was monitored by track counts conducted in November 1988 and March 1989 and pellet counts conducted in June 1988 and 1989 (see Snowshoe Hare Cycle).

For a two week period up to seven traps were set in an area called "Fox Run" distant from the core area of trapping. No lynx were captured during 83 trap-nights of effort. This area is not included in the results provided here and will not be trapped in future.

Results

Trapping Success

Traps were set on up to 41 km of line for a total of 1285 trap-nights (TN). Fifteen lynx were captured, 85.7 TN per lynx. Trap success was higher with the Soft-catch (41.8 TN per lynx)

than with the Freemont (106.0 TN per lynx). No lynx were captured in box traps. Problems with the Freemont trap led to lynx triggering traps but avoiding capture five times; lynx triggered Freemont traps on average once per 68.1 TN. Modifications to the trap and sets eliminated loss of lynx by the end of the trapping session.

Males (73%) and kits (60%) dominated in number of captured lynx (Table 10). Six adults and four kits were collared. The ages of some lynx are in question; aging from I3 teeth is difficult, and several of the ages provided by Matson's are not supported by field evidence. Many of the kits captured early in the trapping session were not radio-collared because only a limited number of collars were available. One male kit (no. 7) tore muscles in his shoulder while in the trap and had to be killed.

Based on track counts and radio-locations, a minimum of 16-18 lynx were estimated to reside within or adjacent to the trapping area in late March 1989, with an average of about 14 lynx per 100 km².

Cleo was the only female "on the air" in late June. Her den was located on 29 June and four kits were tagged. Their estimated age was 3-4 weeks. Based on carcass analysis of lynx in the Ft. Providence area, mean litter size in spring 1988 was high, with only one of 14 females 1-year-old and older showing no recent placental scars, and a mean of 4.46 scars per productive female.

Table 10. Lynx captured at the Sanctuary lynx study area,
6 March - 28 June 1989.

<u>ID/Name</u>	<u>Sex</u>	<u>Age</u>	<u>Weight (Kg)</u>	<u>Date Captured</u>	<u>Eartags L/R</u>	<u>Radio Freq (MHz)</u>
1 --	M	0	6.5	06 03 89	802/803	--
2 Cleo	F	1	9.1	06 03 89	804/803	150.630
3 --	M	0	7.2	07 03 89	806/805	--
4 --	M	0	6.2	07 03 89	807/808	--
5 Tyson	M	2	12.7	08 08 89	811/810	150.510
6 Old Man	M	1	11.1	16 03 89	813/812	150.690
7 --	M	0	7.4	17 03 89	815/814	-- Deceased
8 --	F	0	7.4	18 03 89	817/816	--
9 Stephanie	F	0?	9.3	26 03 89	818/819	150.710
10 Mario	M	0?	11.8	26 03 89	820/821	150.760
11 Wayne	M	0?	9.7	28 03 89	824/822	150.650
12 Nahanni	F	0	6.7	01 04 89	825/826	150.570
13 Tom	M	0	6.8	01 04 89	828/827	150.540
14 Dick	M	0	7.7	01 04 89	830/829	150.740
15 Alex	M	0	6.5	03 04 89	831/832	150.780
16 --	F	-	0.80	29 06 89	98/97	Cleo's Kits
17 --	F	-	0.78	29 06 89	96/95	"
18 --	M	-	0.84	29 06 89	94/93	"
19 --	M	-	0.90	29 06 89	92/91	"

? Denotes aged as kits by Matson's Laboratory, but likely long-yearlings (1 age class) based on weight.

No mortality of collared lynx has been verified to present. Portions of the Sanctuary were trapped during 1988-89, and over 70 lynx were taken (mean harvest density of 1.2 lynx/100 km²). Kits formed 32% and yearlings 51% of the lynx taken adjacent to the study area.

Track Counts

The number of lynx tracks counted on the traplines was fairly linear ($r^2=0.99$) over the March trapping session. On average 0.166 tracks per km-day were observed.

Radio-telemetry

The 10 collared lynx were located a total of 58 times from the ground during the trapping session. Aerial relocation started on 13 April 1989, and has continued every two weeks. One of the collared females (Stephanie) has not been located since aerial tracking began, and may have left the study area. Another female, a kit named Nahanni, was located in mid-July, 105 km west of where she was trapped, after leaving the study area in mid-April. With the exception of these two females, all lynx have been located on each flight. Most of the lynx have stayed within or relatively close to the trapping area. Details on home range size, habitat use and movements will be reported later.

Discussion

The minimum density of lynx estimated for the study area (about 14 /100 km²) is similar to densities found in other studies where hares were abundant (range of 7-20 lynx/100 km²) (Brand et al. 1976, Parker et al. 1983, Banville 1986, Noiseux and Doucet 1987). Lynx densities during years with low hare numbers are reported to be 1.4-5.5 lynx/100 km² (Brand et al. 1976, Stephenson 1986).

A large proportion of the lynx in the area in March were kits. March may be a period of kit dispersal, such that lynx produced on or near the study area may make some extended movements to find new territories. Local trappers note that trap success increases in late February and March, with tracks observed and lynx captured in areas where no tracks had been observed since early winter. Long distance movements of over 100 km have been reported primarily during or after a decline in hare numbers (Ward and Krebs 1985).

The preponderance of males in the live-captured sample and the problems with missing some lynx early in the session suggest that some lynx residing on the study area, possibly some adult females, may not have been captured. Further trapping sessions will be conducted in early and late winter of 1989-90.

ACKNOWLEDGEMENTS

Much of this research would not be possible without the cooperation of DRR staff in the communities, who act as a crucial link with lynx trappers. Their efforts in measuring pelts are appreciated. Special thanks to Officers in Fts. Simpson, Providence and Smith for coordinating carcass collections.

I was assisted in carcass analysis by Bruno Croft, Furbearer Technician, Yellowknife. Bruno also provided invaluable assistance during live-trapping sessions in the Sanctuary. Danny McQueen, Ft. Providence, gave freely of his time and vast experience in lynx trapping that enhanced our trapping efforts. Additional assistance was provided by Mika Sutherland, Yellowknife for data entry skills and field work; Helmut Epp, NWT Centre for Remote Sensing, Yellowknife, by providing habitat classification maps from satellite imagery; Alan Fehr, Aklavik, and Linda Graf, Inuvik, for hare pellet count data from the Inuvik area.

I thank Rus Hall, Supervisor of Fur Management, Yellowknife, for advise and encouragement during development of this program, and for assistance in radio-tracking lynx. Boyd Warner and Donna Prowse from Air Tindi in Yellowknife provided capable and safe radio-tracking flights. Earlier drafts of this report were reviewed by Rus Hall, Mika Sutherland and Alison Welch.

Finally, and most importantly, I appreciate the extra efforts of lynx trappers who cooperated in aspects of this

research by donating carcasses. I extend special thanks to Art Look, Ft. Providence, for his support of our radio-collaring project and permission to live-trap lynx on portions of his trapping area.

PERSONAL COMMUNICATIONS

Archibald, R., Furbearer and Carnivore Specialist, B.C. Ministry of Environment and Parks, Victoria, B.C.

Melchior, H., Furbearer Biologist, Alaska Department of Fish and Game, Fairbanks, Alaska.

Neumann, F., Trapper Education Coordinator, Alberta Department of Energy and Natural Resources, Edmonton, Alberta.

Stephenson, R.O., Research Biologist, Alaska Department of Fish and Game, Fairbanks, Alaska.

LITERATURE CITED

- Bailey, T.N, E.E. Bangs, M.F. Portner, J.C. Malloy and R.J. McAvinchey. 1986. An apparent overexploited lynx population in the Kenai Peninsula, Alaska. *J. Wildl. Manage.* 50:279-290.
- Banville, D. 1986. Étude écologique du lynx du Canada sur la haute côte-nord. Québec Min. du Loisir, de la Chasse et de la Pêche. 56pp.
- Bostock, H.S. 1964. A provisional physiographic map of Canada. Geological Survey of Canada. Paper No. 64-35. 24pp.
- Brand, C.J. and L.B. Keith. 1979. Lynx demography during a snowshoe hare decline in Alberta. *J. Wildl. Manage.* 43:827-849.
- Brand, C.J., L.B. Keith and C.A. Fischer. 1976. Lynx responses to changing snowshoe hare densities in central Alberta. *J. Wildl. Manage.* 40:416-428.
- Canada, Atmospheric Environment Service. 1982. Canadian climate normals 1951-1980, temperature and precipitation; the North - Y.T. and N.W.T. Environment Canada, Canadian Climate Program. 55pp.
- Caughley, G. 1977. Analysis of vertebrate populations. John Wiley & Sons, New York. 234pp.
- Crowe, D.M. 1972. The presence of annuli in bobcat tooth cementum layers. *J. Wildl. Manage.* 36:1330-1332.
- Elton, C., and M. Nicholson. 1942. The ten-year cycle in numbers of the lynx in Canada. *J. Anim. Ecol.* 11:215-244.
- Hatler, D.F. 1988. A lynx management strategy for British Columbia. Wildlife Working Report No. WR-34. B.C. Min. Envir. and Parks. 115pp.
- Keith, L.B. 1963. Wildlife's ten-year cycle. Univ. of Wisconsin Press, Madison. 201pp.
- Koehler, G.M. 1987. The ecology of the lynx (Lynx canadensis) in north-central Washington. Unpubl. Rep., Wildl. Res. Inst. 25pp.
- Krebs, C.J., G.S. Gilbert, S. Boutin and R. Boonstra. 1987. Estimation of snowshoe hare population density from turd transects. *Can. J. Zool.* 65:565-567.

- Mech, L.D. 1983. Handbook of animal radio-tracking. Univ. of Minn. Press, Minneapolis, MN. 107pp.
- Mychasiw, L. and S. Moore. In prep. Primary range survey of the Mackenzie Bison Sanctuary. NWT Renewable Resources File Rep. No. 73. 107pp.
- Nellis, C.H., S.P. Wetmore, and L.B. Keith. 1972. Lynx-prey interactions in central Alberta. J. Wildl. Manage. 36:320-329.
- Noiseux, F. and G.J. Doucet. 1987. Étude de la population du lynx du Canada (Lynx canadensis) de la Réserve Faunique des Laurentides, Québec. Québec Min. du Loisir, de la Chasse et de la Pêche. 81pp.
- O'Connor, R.M. 1984. Population trends, age structure and reproductive characteristics of female lynx in Alaska, 1963 through 1973. M.Sc. thesis, Univ. of Alaska, Fairbanks. 111pp.
- Parker, G.R., J.W. Maxwell, L.D. Morton, and G.E.J. Smith. 1983. The ecology of the lynx (Lynx canadensis) on Cape Breton Island. Can. J. Zool. 61:770-786.
- Quinn, N.W.S. and J.F. Gardner. 1984. Relationships of age and sex to lynx pelt characteristics. J. Wildl. Manage. 48:953-956.
- Quinn, N.W.S. and J.E. Thompson. 1985. Age and sex of trapped lynx, Felis canadensis, related to period of capture and trapping technique. Can. Field-Nat. 99:267-269.
- Quinn, N.W.S. and J.E. Thompson. 1987. Dynamics of an exploited Canada lynx population in Ontario. J. Wildl. Manage. 51:297-305.
- Rowe, J.S. 1972. Forest regions of Canada. Can. Forest Serv. Pub. No. 1300. 172pp.
- SAS. 1988. SAS/STAT user's guide. SAS Institute, Cary, NC.
- Saunders, J.K. Jr. 1964. Physical characteristics of the Newfoundland lynx. J. Mamm. 45:36-47.
- Stephenson, R.O. 1986. Development of lynx population estimation techniques. Alaska Dept. Fish and Game, Job 7.12. 84pp.
- Thompson, I.D., I.J. Davidson, S. O'Donnell, and F. Brazeau. 1989. Use of track transects to measure the relative occurrence of some boreal mammals in uncut forest and regeneration stands. Can. J. Zool. 67:1816-1823.

- Todd, A.W. 1983. Dynamics and management of lynx populations in Alberta. Unpubl. rep., Alberta Fish and Wildlife. 23pp.
- Ward, R.M.P. and C.J. Krebs. 1985. Behavioural responses of lynx to declining snowshoe hare abundance. Can. J. Zool. 63:2817-2824.
- Ward, R.M.P., and B.G. Slough. 1987. Lynx management progress report 1986/87. Pp. 33-56. In: B.G. Slough and R.M.P. Ward. Furbearer management program, 1986/87 annual progress report. Yukon Dept. Renewable Resources. 59pp.